PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT
(PCT Article 36 and Rule 70)

Applicant's or agent's file reference WO 21.1099	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)

International application No. PCT/EP 03/12205	International filing date (day/month/year) 27.10.2003	Priority date (day/month/year) 13.12.2002

International Patent Classification (IPC) or both national classification and IPC G01V3/20

Applicant SERVICES PETROLIERS SCHLUMBERGER

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 5 sheets, including this cover sheet.

   ☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of 3 sheets.

3. This report contains indications relating to the following items:

   I   ☒   Basis of the opinion

   II   ☐   Priority

   III   ☐   Non-establishment of opinion with regard to novelty, inventive step and industrial applicability

   IV   ☐   Lack of unity of invention

   V   ☒   Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

   VI   ☐   Certain documents cited

   VII   ☐   Certain defects in the international application

   VIII   ☐   Certain observations on the international application

Date of submission of the demand 09.07.2004	Date of completion of this report 04.04.2005

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I. Basis of the report

1. With regard to the **elements** of the international application *(Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17))*:

   Description, Pages

   1-22   as originally filed

   Claims, Numbers

   1-15   received on 10.03.2005 with letter of 10.03.2005

   Drawings, Sheets

   1/8-8/8   as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

   These elements were available or furnished to this Authority in the following language: , which is:

   ☐   the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).

   ☐   the language of publication of the international application (under Rule 48.3(b)).

   ☐   the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

   ☐   contained in the international application in written form.

   ☐   filed together with the international application in computer readable form.

   ☐   furnished subsequently to this Authority in written form.

   ☐   furnished subsequently to this Authority in computer readable form.

   ☐   The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

   ☐   The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

   ☐   the description,   pages:

   ☐   the claims,   Nos.:

   ☐   the drawings,   sheets:

5. ☐   This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)).

(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-5, 8, 9-15 (when dependent on claim 1)
	No:	Claims	6, 7, 9-15 (when dependent on claim 6)
Inventive step (IS)	Yes:	Claims	1-5, 8, 9-15 (when dependent on claim 1)
	No:	Claims	6, 7, 9-15 (when dependent on claim 6)
Industrial applicability (IA)	Yes:	Claims	1-15
	No:	Claims	

2. Citations and explanations

see separate sheet

Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1　Reference is made to the following documents:

D1:　US-A-4 517 835 (KERZNER MARK G) 21 May 1985 (1985-05-21)
D2:　SZENDRO D: "Automatic relative depth matching of borehole information. I. Theoretical review" GEOPHYSICAL TRANSACTIONS, vol. 32, no. 4, April 1987 (1987-04), pages 333-353, XP008019187

2　Independent claims 1 and 6

2.1　The document D1 is regarded as being the closest prior art to the subject-matter of claim 1 and shows (the references in parentheses applying to this document) a method for matching a plurality of data sets (23A, 24A, 25A, 26A) from boreholes, the data sets being obtained from sensors (23-26). The data-sets are two-dimensional (being a function of depth and azimuth, see column 6, line 56 to column 7, line 3 and figure 1) and are indicative of dip in the vicinity of the borehole (column 8, lines 12-16).
The subject-matter of claim 1 differs from this known method in that
(a) the two-dimensional data sets are transformed into three-dimensional images using the Hough transform;
(b) two-dimensional curves are derived from the three-dimensional images by the application of the Hough transform to depth derivatives of sensor signals, generated by sensors; and
(c) an offset is derived from the two-dimensional curves for applying to the two dimensional data sets to depth match them to each other.
The subject-matter of claim 1 is therefore new (Article 33(2) PCT).

The problem to be solved by the present invention may be regarded as providing an efficient depth-matching method. This problem is solved by the features (a), (b), and (c) above, which are not disclosed or suggested in the available prior art. The solution to this problem proposed in claim 1 is therefore considered as involving an inventive step (Article 33(3) PCT).

2.2　The present application does not meet the criteria of Article 33(1) PCT, because the subject-matter of claim 6 is not new in the sense of Article 33(2) PCT.

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The document D1 discloses (the references in parentheses applying to this document) the matching of a plurality of data sets (23A, 24A, 25A, 26A) being obtained from sensors (23-26). The data-sets are two-dimensional (being a function of depth and azimuth, see column 6, line 56 to column 7, line 3 and figure 1) and are indicative of dip in the vicinity of the borehole (column 8, lines 12-16). For each data set individual signals are combined to create an averaged signal (23B, 25B) (column 8, lines 50-66) (the activity functions 23B and 25 B are clearly obtained by spatially averaging around respective depth points). An offset is calculated and the curves are depth matched (column 11, lines 30-64). The subject-matter of claim 6 is therefore not new.

3   Dependent claims 2-5 and 7-15

3.1   Claims 2-5 and claims 9-15, when referring to claim 1, are dependent on claim 1, whose subject-matter is new and inventive as shown under point 2.1, and as such also meet the requirements of the PCT with respect to novelty and inventive step.

3.2   Dependent claims 7 and 9-15, when referring to claim 6, do not contain any features which, in combination with the features of claim 6, meet the requirements of the PCT in respect of novelty and/or inventive step (see document D1, column 8, lines 50-68 and column 11, lines 14-64, and document D2, page 334, paragraph 4 - page 335, paragraph 1).

CLAIMS

1.   A method for matching a plurality of data sets from boreholes or core sections, the data sets being obtained from sensors are two-dimensional data sets and are indicative of earth formation, boundary, or interface of earth formations and of dip in the vicinity of the borehole, the method for depth matching being characterized in that:

    (a) the two-dimensional data sets are transformed into three-dimensional images using the Hough transform;

    (b) two dimensional curves are derived from the three-dimensional images by the application of the Hough transform to depth derivatives of sensor signals, generated by sensors; and

    (c) an offset is derived from the two-dimensional curves for applying to the two dimensional data sets to depth match them to each other.

2.   The method in accordance with claim 1 wherein the method is further characterized in that the two dimensional curves have peaks indicating dip events in the vicinity of the borehole.

3.   The method in accordance with claim 1 wherein the method is further characterized in that the two-dimensional data sets have gaps in the data and the three-dimensional images created using the Hough transform are immune from the gaps.

4.   The method in accordance with claim 1 wherein the method is further characterized in that two-dimensional curves for data sets from sensors that are vertically spaced from each other longitudinally along the borehole are processed to determine an offset that will match the two-dimensional curves.

5.   The method in accordance with claim 4 wherein the method is further characterized in that the determined offset is applied to the data sets from the vertically spaced sensors to depth match the data sets to each other.

AMENDED SHEET

6.   A method for matching a plurality of data sets from boreholes or core sections, the data sets being obtained from sensors are two-dimensional data sets and are indicative of a boundary, or interface of earth formations and of dip in the vicinity of the borehole, the method for depth matching being characterized in that:

for each two-dimensional data set of the plurality of data sets, individual signals making up the respective two-dimensional data set are combined to create an averaged signal;

averaged signals, each corresponding to one two-dimensional data set, are processed to calculate an offset that correlates the averaged signals; and

the calculated offset is applied to the two-dimensional data sets to depth match them to each other.

7.   The method of claim 6 wherein said averaged signal are obtained by determining an average of the sensor signals along the bedding dip for a given depth in the borehole.

8.   The method of claim 7 wherein said computation of bedding dips for the sensor signals is performed by way of the Hough transform.

9.   The method in accordance with claims 1 or 6 wherein the method is further characterized in that two-dimensional data sets to be depth matched are obtained at the same time by sensors that are vertically spaced from each other longitudinally along the borehole.

10.   The method in accordance with claims 1 or 6 wherein the method is further characterized in that two-dimensional data sets to be depth matched are obtained at different times for the same borehole.

11.   The method in accordance with claims 1 or 6 wherein the method is further characterized in that a two-dimensional data set to be depth matched is obtained from a core section.

12.   The method of claims 1 or 6 wherein each of said sensor signals is obtained from a sensor of a plurality of sensors.

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13.   The method of claim 12 wherein each sensor includes a plurality of sub sensors.

14.   The method of claim 13 wherein each signal includes a trace, the trace being a side-by-side combination of signals from the plurality of sub sensors.

15.   The method in accordance with claims 1 or 6 wherein the method is further characterized in that it is applicable to real time depth matching of data sets from sensors that are vertically spaced from each other longitudinally along the borehole.